

Flowers and insects. XV.¹

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POLYGONUM Tourn.—For the present I withhold the consideration of the mode of pollination and of the copious special literature and contribute lists of insect visitors of the two following species.

POLYGONUM PENNSYLVANICUM L.—The visitors observed on nine days between Aug. 8th and Sept. 16th, are as follows:

HYMENOPTERA—*Apidae*: (1) *Apis mellifica* L. ♀, ab.; (2) *Bombus separatus* Cr. ♂; (3) *B. americanorum* F. ♂♀; (4) *B. virginicus* Oliv. ♂♀, ab.; (5) *Megachile brevis* Say ♂; *Andrenidae*: (6) *Andrena asteris* Rob. ♂; (7) *Agapostemon radiatus* Say ♂; (8) *Augochlora viridula* Sm. ♀; (9) *A. pura* Say ♀; (10) *Halictus fasciatus* Nyl. ♀; (11) *H. pilosus* Sm. ♀; (12) *H. confusus* Sm. ♀; (13) *H. stultus* Cr. ♀; *Vespidæ*: (14) *Polistes pallipes* Lep.; (15) *P. rubiginosus* Lep.; (16) *P. metricus* Say; (17) *P. annularis* L.; *Eumenidae*: (18) *Odynerus tigris* Sauss., freq.; (19) *O. capra* Sauss., freq.; *Crabronidae*: (20) *Crabro interruptus* Lep.; (21) *C. 6-maculatus* Say; *Philanthidae*: (22) *Cerceris clypeata* Dlb.; *Larridae*: (23) *Ancistromma distincta* Sm.; *Sphecidae*: (24) *Ammophila intercepta* Lep.; (25) *Chlorion caeruleum* Dru.; (26) *Priononyx atrata* Lep.; *Pompilidae*: (27) *Pompilus philadelphicus* Lep.; (28) *Priocnemis fulvicornis* Cr.; (29) *Planiceps niger* Cr.; *Scoliidae*: (30) *Myzine sexcincta* F.—all sucking.

DIPTERA—*Bombylidae*: (31) *Sparnopolius fulvus* Wd.; *Syrphidae*: (32) *Syrphus ribesii* L.; (33) *S. americanus* Wd., freq.; (34) *Mesograpta polita* Say; (35) *M. marginata* Say; (36) *Eristalis tenax* L.; (37) *E. aeneus* F.; (38) *Tropidia quadrata* Say; (39) *Syritta pipiens* L.; *Tachinidae*: (40) *Cistogaster immaculata* Mcq.; (41) *Jurinia smaragdina* Mcq., ab.; (42) *J. apicifera* Wlk.; (43) *Micropalpus fulgens* Mg.; (44) *Frontina acroglossoides* Twns.; (45) *F. flavicauda* Riley; (46) *Atrophopoda singularis* Twns.; *Sarcophagidae*: (47, 48) *Sarcophaga* spp.; *Muscidae*: (49) *Graphomyia* sp., freq.; (50) *Lucilia caesar* L.; (51) *L. cornicina* F.; (52) *Compsomyia macellaria* F.—all sucking.

LEPIDOPTERA — *Rhopalocera*: (53) *Pieris protodice* B.-L.; (54) *P. rapæ* L.; (55) *Colias philodice* Gdt.; (56) *Chrysophanus thoe* B.-L.; (57) *Pamphila cernes* B.-L.; *Heterocera*: (58) *Heliothis armiger* Hüb.; (59) *Scepsis fulvicollis* Hüb.—all sucking.

COLEOPTERA — *Lampyridæ*: (60) *Chauliognathus pennsylvanicus* DeG., s., ab.

POLYGONUM HYDROPIPEROIDES Michx.—The following visitors were observed Aug. 30th and Sept. 20th:

¹Contributions to an account of the ecological relations of the entomophilous flora and the anthophilous insect fauna of the neighborhood of Carlinville, Illinois.

HYMENOPTERA—*Apidæ*: (1) *Apis mellifica* L., ♀; (2) *Ceratina dupla* Say ♀; (3) *Megachile brevis* Say ♂; (4) *M. mendica* Cr. ♀; *Andrenidæ*: (5) *Andrena solidaginis* Rob. ♀; (6) *Agapostemon radiatus* Say ♂ ♀; (7) *Halictus coriaceus* Sm. ♂, freq.; (8) *H. lerouxii* Lep. ♀; (9) *H. fasciatus* Nyl. ♀; (10) *Colletes armata* Ptn. ♂; (11) *C. eulophi* Rob. ♂; (12) *C. americana* Cr. ♂ ♀, freq.; (13) *C. latitarsis* Rob. ♀; (14) *Prosopis pygmaea* Cr. ♂; *Vespidæ*: (15) *Polistes pallipes* Lep.; (16) *P. metricus* Say; *Eumenidæ*: (17) *Odynerus capra* Sauss.; (18) *O. dorsalis* F.; (19) *O. arvensis* Sauss.; *Crabronidæ*: (20) *Crabro texanus* Cr.; (21) *C. trifasciatus* Say; (22) *Thyreopus tumidus* Pack.; (23) *Anacrabro ocellatus* Pack.; (24) *Oxybelus 4-notatus* Say; (25) *O. emarginatus* Say; *Philanthidæ*: (26) *Philanthus ventilabris* F.; (27) *P. punctatus* Say; (28) *Eucerceris zonatus* Say; (29) *Cerceris fumipennis* Say; (30) *C. kennicottii* Cr.; *Nyssonidæ*: (31) *Gorytes phaleratus* Say; *Larridæ*: (32) *Astata bicolor* Say; (33) *Ancistromma distincta* Sm.; (34) *Tachytes aurulentus* F.; *Sphacidæ*: (35) *Pelopoeus cementarius* Dru.; (36) *Isodontia philadelphia* Lep.; (37) *Sphex ichneumonea* L.; (38) *Priononyx thomæ* F.; (39) *P. atrata* Lep.; *Pompilidæ*: (40) *Pompilus philadelphicus* Lep.; (41) *P. algidus* Sm.; (42) *P. biguttatus* F.; (43) *P. navus* Cr.; (44) *Ceropales fraterna* Sm.; *Scoliidæ*: (45) *Tiphia tarda* Say; (46) *Myzine sexcincta* F.; *Mutillidæ*: (47) *Sphaerophthalma macra* Cr.; *Chrysididæ*: (48) *Holopyga ventralis* Say; (49) *Hedychrum wiltii* Cr.; (50) *H. violaceum* Brullé; (51) *Chrysis texana* Grib.; (52) *C. nitidula* F.

DIPTERA—*Bombylidæ*: (53) *Systoechus vulgaris* Lw.; *Conopidæ*: (54) *Conops brachyrrhynchus* Mcq.; *Syrphidæ*: (55) *Paragus tibialis* Fl.; (56) *Eristalis bastardi* Mcq.; (57) *E. flavipes* Wlk.; (58) *Tropidia quadrata* Say; (59) *Syritta pipiens* L.; *Tachinidæ*: (60) *Jurinia apicifera* Wlk.; (61) *Frontina acroglossoides* Twms.; *Sarcophagidæ*: (62–64) *Sarcophaga* spp.; *Muscidæ*: (65) *Lucilia caesar* L.; (66) *L. cornicina* F.; (67) *Compsomyia macellaria* F.; *Anthomyidæ*: (68) *Coenosia* sp.

COLEOPTERA—*Coccinellidæ*: (69) *Coccinella 9-notata* Hbst.; *Lampyridæ*: (70) *Chauliognathus pennsylvanicus* DeG.; *Chrysomelidæ*: (71) *Disonycha limbicollis* Lec. v. *pallipes* Cr.; *Curculionidæ*: (72) *Listronotus caudatus* Say.

DIRCA PALUSTRIS L.—This is a low shrub blooming quite early, March 18th to April 13th, and bearing small greenish yellow flowers which appear before the leaves. At the ends of the branchlets are situated buds of about four hairy scales enclosing, in cases observed by me, three flower-buds and a leaf-bud. The flowers are pendulous and are sheltered by the bud scales which form a hood above them.

The calyx tube is about 5^{mm} long and is truncate, with obscure lobes. The bottom of the tube is completely filled by the ovary so that with a proboscis 4^{mm} long a bee may obtain all the nectar, which I think is secreted by the tube. For the distance of about 1^{mm} from the ovary to the point where the stamens are inserted the tube is narrow. Above that point it is wider but is obstructed by the eight filaments and the

style. The anthers are exerted about 2^{mm} beyond the mouth of the tube, the alternate ones being somewhat shorter. The stigma is advanced about 2^{mm} further.

In a bud which had just begun to open I found that the flowers had the anthers reaching just to the mouth, but the stigmas advanced 2^{mm} beyond. The anthers were closed but the stigmas were receptive. There was thus an appearance of proterogyny, but it must be short-lived, for all of the other flowers which I observed had the anthers dehiscent, the larger ones, however, shedding their pollen first. The arrangement for cross-pollination is the simple one, common in pendulous flowers, of the stigma being in advance of the anthers. Pollination between flowers of the same plant may occur, but I think there is little chance of self-pollination.

As noted above, the calyx has obscure lobes, and my examination of early cases, in which the open mouths of the tubes were crowded with the swollen anthers, leads me to believe that the abortion of the lobes is correlated with the fact that the young flowers are protected by the scales which form the common envelope of the leaf-bud and the flower cluster.

The pendulous position of the flowers, the comparatively deep, narrow tube, and the early blooming time convince me that the flowers are adapted to the smaller bees. The following list of visitors, observed March 21st, confirms this view:

HYMENOPTERA—*Apidae*: (1) *Ceratina dupla* Say ♂; (2) *C. tejonensis* Cr. ♂; (3) *Osmia lignaria* Say ♂; (4) *Nomada maculata* Cr. ♂; *Andrenidae*: (5) *Halictus* sp. ♀; (6) *H. zephyrus* Sm. ♀; (7) *H. confusus* Sm. ♀; (8) *Augochlora labrosa* Say ♀; (9) *Andrena rugosa* Rob. ♂; (10) *Colletes inaequalis* Say ♂—all s.

LEPIDOPTERA—*Nymphalidae*: (11) *Vanessa antiopa* L., s.

EUPHORBIA L.—As in the case of *Polygonum*, I omit remarks upon the mode of pollination and references to the literature.

EUPHORBIA COROLLATA L.—The stems grow from 6 to 10^{dm} high and are terminated by large umbel-like clusters with white involucre which make it the most conspicuous of our Euphorbias.

It was observed in bloom from May 24th to Sept. 27th. The following list, consisting mainly of flies, on which the plant seems to depend, with the exception of no. 1, was observed on July 25th:

DIPTERA—*Bombylidæ*: (1) *Anthrax alternata* Say; *Syrphidæ*: (2) *Paragus tibialis* Fll.; (3) *P. bicolor* F.; (4) *Pipiza pulchella* Will.; (5) *Chrysogaster nitida* Wd.; (6) *Allograpta obliqua* Say; (7) *Spaerophoria cylindrica* Say; (8) *Syritta pipiens* L.; *Tachinidæ*: (9) *Cistogaster immaculata* Mcq.; (10) *Miltogramma argentifrons* Twms.; *Muscidæ*: (11) *Lucilia cornicina* F.; (12) *Cyrtoneura* sp.

HYMENOPTERA—*Andrenidæ*: (13) *Prosopsis pygmaea* Cr. ♀; *Pompilidæ*: (14) *Pompilus relativus* Fox.—all sucking.

HEMIPTERA—*Coreidæ*: (15) *Chariesterus antennator* F., s.

SALIX Tourn.—The flowers of willows are dioecious and entomophilous, but Warming (21) regards *S. herbacea* and some other species as anemophilous in Greenland. In the Alps, according to Müller (15), *S. herbacea* secretes abundant nectar and is visited by insects. Kerner (24) observed some species to be proterogynous, with the result that at first they could only receive pollen from flowers of other species and consequently produced hybrids.

Sprengel (1) regarded the staminate catkins as being more conspicuous than the pistillate in order that the latter might thus be more likely to be visited by insects which had first become dusted with pollen from the staminate flowers. While it is a fact that the staminate catkins are more attractive to insects, and, in spite of Bonnier's (11) statements to the contrary, are more abundantly visited by them, it can hardly be maintained that the increased conspicuousness was developed on this account, for, as claimed by MacLeod (27), the staminate flowers of anemophilous plants are also more conspicuous than the others. I have often noticed that the catkins of *Populus monilifera* were quite red or yellow, making them more brightly colored than in any of our species of *Salix*.

From their readily accessible nectar and exposed pollen, the catkins are especially attractive to the less specialized bees (*Andrenidæ*) and to the flower flies (*Syrphidæ*) and in most of the cases given in the table these are the most abundant guests, together forming a majority of all the visitors. Except for the services of these insects there seems to be little reason why the flowers should bloom early, for all of the other insect groups, except the *Empidæ*, have more species later in the season. I suspect that, whenever a satisfactory list of visitors of a willow is made out, it will show a preponderance of *Andrenidæ* and *Syrphidæ*, unless there is some peculiarity in the insect fauna of the region.

The following table gives the results of observations made

in different regions in cases in which the insects have been identified:

SALIX.	REGION.	OBSERVER.	ANDRENIDÆ AND SYRPHIDÆ.		OTHER INSECTS.		OTHER HYMENOPTERA.		OTHER DIPTERA.		OTHER INSECTS.	
			ANDRENIDÆ	SYRPHIDÆ.	OTHER	OTHER	APIDÆ.	ANDRENIDÆ.	SYRPHIDÆ.	OTHER	OTHER	
cordata	Illinois . . . . .	.....	49	38	7	8	28	21	18	5		
humilis	Illinois . . . . .	.....	27	24	5	3	20	7	9	7		
cinerea	Germany..	Müller (6, 12, 17)..	61	52	9	19	44	17	16	8		
caprea												
aurita												
cinerea	Germany..	Loew (20).....	1	1	.....	1	1	.....	.....	.....
caprea	Germany..	Loew (28).....	11	5	.....	4	11	.....	1	.....	
aurita	Germany..	Loew (20, 28).....	1	2	.....	1	1	.....	1	.....	
nigricans	Germany..	Loew (20).....	1	1	.....	1	1	.....	.....	.....
alba	Germany..	Loew (28).....	.....	1	.....	.....	.....	.....	1	.....	
amygdalina..	Germany..	Loew (28).....	1	.....	.....	.....	1	.....	.....	.....
amygdalina..	Germany..	Müller (12).....	2	3	.....	1	2	.....	2	.....	
fragilis	Germany..	Müller (12).....	2	4	1	1	2	.....	.....	.....
repens	Germany..	Müller (6, 17)	4	6	1	2	4	.....	2	.....	
repens	Norderney	Verhoeff (26)	7	26	2	4	1	6	14	6		
Early spp	Flanders..	Mac Leod (27).....	15	28	5	6	12	3	15	2		
Late spp	Flanders..	Mac Leod (27).....	7	5	.....	1	3	4	4	.....	
herbacea	Alps.....	Müller (15, 17).....	.....	2	.....	.....	.....	.....	1	.....	
reticulata	Alps.....	Müller (15).....	.....	1	.....	.....	.....	.....	.....	.....
retusa	Alps.....	Müller (15).....	.....	1	1	.....	.....	.....	.....	.....

Those species which bloom before the leaves appear—as in the two following cases—are more abundantly visited because they have fewer competitors, and because their flowers are less concealed by the leaves.

SALIX CORDATA Muhl. blooms from March 18th to April 23d. On April 9–11th, 14th, 17th, 18th, and 20th the following insects were taken on the flowers:

HYMENOPTERA—*Apidae*: (1) *Ceratina dupla* Say ♂, s., freq.; (2) *Osmia lignaria* Say ♂, s.; (3) *Nomada sayi* Rob. ♂♀, s., very ab.; (4) *N. maculata* Cr. ♂♀, s., very ab.; (5) *N. luteola* Lep. ♂♀, s., ab.; (6) *N. luteoloides* Rob. ♂, s.; (7) *N. articulata* Sm. ♂, s.; (8) *N. integra* Rob. ♂♀, s., ab.; *Andrenidæ*: (9) *Andrena erythrogaster* Ashm. ♂♀, s., and c. p., ab., in cop.; (10) *A. sayi* Rob. ♂♀, s., ab., in cop.; (11) *A. salicis* Rob. ♂♀, s. and c. p.; (12) *A. illinoensis* Rob. ♂♀, s. and c. p., ab., in cop.; (13) *A. flavo-clypeata* Sm. ♂♀, s., ab., in cop.; (14) *A. cressonii* Rob. ♂, s., ab.; (15) *A. nuda* Rob. ♀, s.; (16) *A. rugosa* Rob. ♂♀, s.; (17) *A. erythronii* Rob. ♂, s.; (18) *A. forbesii* Rob. ♀, s.; (19) *A. hippotes* Rob. ♂, s.; (20) *A. mariæ* Rob. ♂♀, s. and c. p., ab.: in cop.; (21) *A. claytoniæ* Rob. ♂♀, s., ab.; (22) *A. mandibularis* Rob. ♂, s.; (23) *A. pruni* Rob. ♂; (24) *Panurgus? andrenoides*

Cr. ♂, s., very ab., in cop.; (25) *Agapostemon radiatus* Say ♀, s.; (26) *Augochlora similis* Rob. ♀, s.; (27) *A. pura* Say ♀, s.; (28) *Halictus foxii* Rob. ♀, s., ab.; (29) *H. forbesii* Rob. ♀, s., (30) *H. lerouxii* Lep. ♀, s., freq.; (31) *H. pilosus* Sm. ♀, s., freq.; (32) *H. zephyrus* Sm. ♀, s.; (33) *H. confusus* Sm. ♀, s.; (34) *H. stultus* Cr. ♀, s.; (35) *Sphecodes arvensis* Ptn. ♀, s.; (36) *Colletes inaequalis* Say ♂, s.; *Vespidæ*: (37) *Polistes rubiginosus* Lep., s.; *Pompilidæ*: (38) *Priocnemis conicus* Say, s.; *Ichneumonidæ*: (39) *Pimpla* sp.; *Tenthredinidæ*: (40) *Nematus vertebratus* Say; (41) *N. luteotergum* Nort.; (42) *Dolerus arvensis* Say, s., ab.; (43) *D. bicolor* Bv., s., freq.

DIPTERA—*Simulidæ*: (44) *Simulium* sp. s.; *Empidæ*: (45) *Empis otiosa* Coq., s.; (46) *Rhamphomyia gilvipilosa* Coq., s.; *Conopidæ*: (47) *Myopa vesiculosa* Say, s.; (48) *M. pilosa* Will.; *Syrphidæ*: (49) *Psilota buccata* Mcq.; (50) *Chrysogaster pictipennis* Will., ab.; (51) *Chilosia* sp.; (52) *Melanostoma obscurum* Say; (53) *Platychirus hyperboreus* Staeg.; (54) *P. quadratus* Say, freq.; (55) *Syrphus ribesii* L.; (56) *S. americanus* Wd., ab.; (57) *Sphaerophoria cylindrica* Say; (58) *Chalcomyia aerea* Lw.; (59) *Brachyopa vacua* O. S.; (60) *Eristalis aeneus* F., ab.; (61) *E. dimidiatus* Wd., ab.; (62) *E. transversus* Wd.; (63) *E. flavipes* Wlk.; (64) *Helophilus similis* Mcq., ab.; (65) *Tropidia mamillata* Lw.; (66) *Brachypalpus rileyi* Will., ab.; (67) *B. frontosus* Lw., very ab.; (68) *Xylota fraudulosa* Lw., ab.; (69) *Syritta pipiens* L.; *Tachinidæ*: (70) *Gonia frontosa* Say, ab.; (71) *G. exul* Will.; *Sarcophagidæ*: (72) *Cynomyia* sp., ab.; *Muscidæ*: (73) *Lucilia cornicina* F., ab.; *Anthomyidæ*: (74) *Chortophila* sp.; *Cordyluridæ*: (75) *Scatophaga squalida* Mg., ab.; *Sciomyzidæ*: (76) *Tetanocera* sp.; (77) *T. pictipes* Lw.; *Lonchaeidæ*: (78) *Lonchaea* sp.; (79) *L. polita* Say; *Sepsidæ*: (80) *Sepsis* sp.; *Oscinidæ*: (81) *Oscinis* sp.; *M. acalyptata*: (82) sp.—all s. or f. p.

COLEOPTERA—*Chrysomelidæ*: (83) *Orsodachna atra* Ahr., ab.; (84) *Lina lapponica* L., ab.; (85) *Galeruca tuberculata* Say, freq.; *Oedemeridæ*: (86) *Asclera puncticollis* Say, freq.—all s. or f. p.

HEMIPTERA—*Capsidæ*: (87) *Lygus pratensis* L. s.

SALIX HUMILIS Marsh.—This species was observed in bloom from the 18th of March to the 21st of April. On March 18th and April 6–12th, 14th, 17th, 20th and 21st the following visitors were noted:

HYMENOPTERA—*Apidæ*: (1) *Apis mellifica* L. ♂, s. and c. p., ab.; (2) *Bombus virginicus* Oliv. ♀; (3) *Ceratina dupla* Say ♂, freq.; *Andrenidæ*: (4) *Andrena vicina* Sm. ♂, ab.; (5) *A. erythrogaster* Ashm ♂; (6) *A. salicis* Rob. ♂, s., freq.; (7) *A. illinoensis* Rob. ♂; (8) *A. erythronii* Rob. ♂; (9) *A. cressonii* Rob. ♂; (10) *A. flavo-clypeata* Sm. ♂; (11) *A. rugosa* Rob. ♂; (12) *A. forbesii* Rob. ♀; (13) *Agapostemon radiatus* Say ♀; (14) *Augochlora pura* Say ♀; (15) *Halictus arcuatus* Rob. ♀; (16) *H. forbesii* Rob. ♀; (17) *H. coriaceus* Sm. ♀; (18) *H. lerouxii* Lep. ♀, ab.; (19) *H. fasciatus* Nyl. ♀; (20) *H. confusus* Sm. ♀; (21) *H. pruinosus* Rob. ♀; (22) *Sphecodes arvensis* Ptn. ♀; (23) *Colletes inaequalis* Say ♂, ab.; *Ichneumonidæ*: (24) *Ichneumon funestus* Cr.; (25) *Colpognathus helvus* Cr.; *Tenthredinidæ*: (26) *Dolerus arvensis* Say, ab.; (27) *D. bicolor* Br., ab.; (28) *D. sericeus* Say—all s.

DIPTERA—*Syrphidæ*: (29) *Syrphus americanus* Wd.; (30) *Sphaerophoria cylindrica* Say; (31) *Eristalis aeneus* F.; (32) *E. dimidiatus* Wd.,

ab.; (33) *E. latifrons* Lw.; (34) *Helophilus similis* Mcq., ab.; (35) *Brachypalpus frontosus* Lw., ab., *Tachinidæ*: (36) *Gonia frontosa* Say, ab.; *Sarcophagidæ*: (37) *Cynomyia* sp., ab.; *Muscidæ*: (38) *Lucilia caesar* L.; (39) *Lucilia cornicina* F., ab.; *Anthomyidæ*: (40-41) *Chortophila* spp.; (42) *Hyetodosia 4-notata* Mg.; *Cordyluridæ*: (43) *Scatophaga squalida* Mg., ab.; *Sepsidæ*: (44) *Sepsis* sp., ab.—all s.

COLEOPTERA—*Coccinellidæ*: (45) *Hippodamia parenthesis* Say; *Lampyridæ*: (46) *Ellychnia corrusca* L.; *Chrysomelidæ*: (47) *Orsodachna atra* Ahr., ab.—all s.

HEMIPTERA—*Lygaeidæ*: (48) *Lygaeus turcicus* F.; *Pentatomidæ*: (49) *Euschistus variolaris* P. B. (det. by Uhler); *Capsidæ*: (50) *Lygus pratensis* L.—all s.

LEPIDOPTERA—*Rhopalocera*: (51) *Vanessa antiopa* L., s.

The staminate flowers are so thoroughly monopolized by hive-bees that other insects are almost entirely absent. Accordingly, most of the insects in the list were taken on the pistillate flowers which they visited only for nectar.

On the literature of *Salix* see:

(1) Sprengel, Das entdeckte Geheimniss 31. 437-8. 1793. *S. caprea* visitors, etc.—(2) Hildebrand, Geschlechter-vertheilung bei den Pflanzen 9. 12. 1867. Diclinism.—(3) Axell, Om anordningarna för de fanerogama växternas befruktning 47, 62, 93, 113. 1869. *S. pentandra, cinerea, nigricans*.—(4) White, Winter fertilization by agency of insects. Journ. Bot. N. S. 1: 48, F 1872. Visitors of ♂ and ♀ fls.—(5) Delpino, Ulteriori osservazioni Pt. II. fasc. 2: (154). 1875. Atti d. Soc. Ital. d. Sci. Nat. in Milano. 16: 302. 1873. Lit. (1) and (4).—(6) Müller, Befruchtung der Blumen 149-50. 1873.—(7) Kerner, Die Schutzmittel des Pollens 50. 1873.—(8) Kerner, Die Schutzmittel der Blüten gegen unberufene Gäste. 1876. *S. daphnoides*, Wachsüberzüge. (Just Bot. Jahresbericht 4: 942).—(9) Meehan, On self-fertilization and cross-fertilization of flowers. Penn Monthly. N 1876. *S. caprea*. Sep. pamphlet 1877. (Just 4: 939).—(10) H. H., Fertilization of *Salix repens*. Nature 16: 184. 1877. Visitors. (Just 5: 746).—(11) Bonnier, Les Nectaires. Ann. d. Sci. Nat. Bot. 8: 39, 49-50, 57, 70-1. 1879. Several spp., visitors, etc.—(12) Müller, Weitere Beobachtungen. II. Verh. d. naturhist. Ver. d. preuss. Rheinl. u. Westf. 1879: 210.—(13) Behrens, Biologische Fragmente. Jahresbericht d. Naturw. Gesellschaft zu Elberfeld. 1880. *S. repens*.—(14) Delpino, Proporzione delle piante anemofile ed entomofile nelle isole. Revista Botanica 1880: 50-2. Lit. (13) (Just 8¹: 190).—(15) Müller, Alpenblumen 162-3. 1881.—(16) Mez, Geschlechtsänderung einer Weide. Deutsch. bot. Monatschr. 1: 93. 1883. *S. purpurea* × *viminalis*. (Just 11¹: 483).—(17) Müller, Fertilization of Flowers 524-6. 1883.—(18) Heinricher, Beiträge zur Pflanzenteratologie und Blütenmorphologie. Sitzber. d. K. Akad. d. Wissensch. Wien 87: 1883. *S. caprea*, androgynous catkins. (Just 11¹: 483).—(19) Müller, Die Stellung der Honigbiene in den Blumenwelt III. Deut. Bienenzeit. 39: 157-61. 1883. (Just 11¹: 476).—(20) Loew, Beobachtungen über den Blumenbesuch von Insekten an Freilandpflanzen des botanischen Gartens zu Berlin. Jahrb. bot. Gartens Berlin 3: 82, 274, 276. (14, 72, 74). 1884.—(21) Warming, Om bygninggen og den formodede bestøvningensmaade af nogle grønlandske blom-

ster. Oversigt over d. K. D. Vidensk. Selsk. Forhandl. 1886: 116, 131, 156.—(22) Pax, Salicaceæ. Engler u. Prantl. Die nat. Pflanzenfamilien. 14: 33. 1887. (Just 16¹: 563).—(23) Bulman, The bee and the willow. Sci. Gossip 1889: 130.—(24) Kerner, Die Bedeutung der Dichogamie. Oest. bot. Zeitschrift 40: 2-3. 1890.—(25) Kerner, Pflanzenleben 2: 187, 311-12. 1891. Several spp. (Just 17¹: 532).—(26) Verhoeff, Blumen und Insekten der Insel Norderney. Nova Acta d. Kais. Leop. Carol. Deutsch. Akad. d. Naturf. 61: 63-8. 1893.—(27) MacLeod, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Bot. Jaarboek 6: 129-33, etc. 1894.—(28) Loew, Blütenbiologische Floristik des mittleren und nördlichen Europa sowie Grönlands. 1894. (11 spp).—(29) Knuth, Blumen und Insekten auf den Nordfriesischen Inseln 131-2. 1894. *S. repens*.—(30) Weed, Ten New England blossoms and their insect visitors. 1-17. 1895. *S. discolor*, visitors, etc.

IRIS Tourn.—In this genus we find regular trilateral nototribe flowers. Each sepal, with a stamen and a style-division, is modified into a form which is almost a functional equivalent of a specialized flower such as we find in the Scrophulariaceæ, etc. The form of the style serves to determine the kind of insect pollinators and secures the application of the pollen to the insect's back. Kerner (5, 23) mentions the style of *Iris* as serving to protect the pollen, without, however, showing the probability of this having anything to do with its development.

Except in the single case mentioned below, the flowers are adapted to bumblebees, but are also visited by other large bees, such as *Xylocopa* (Delpino 6), and in this country by *Synhalonia*. *I. pseudacorus* (Müller 4) presents an interesting case of what Errera and Gevaert (11) call *dientomophily*—having one form adapted to bumblebees and another adapted to *Rhingia rostrata*, a Syrphid fly. The only other case as yet recorded is that of *Aconitum lycoctonum*, observed by Aurivillius (see Ludwig 19, 25), which has one form visited by bumblebees and another visited by butterflies. Gibson (28) in an account of the blue-flag, accompanied by a figure evidently of *I. versicolor*, implies that *Iris* in general is adapted to bumblebees and large flies. "A large fly" is a rather loose synonym for *Rhingia rostrata*.

Iris has sometimes been used as a type of hercogamy (erogame contingente, Delpino 6), but *I. sibirica* has been shown to be proterandrous (Dodel Port 24, Loew 30). It will be seen below that *I. versicolor* is also proterandrous to some extent. Meehan (9) records a case in which *I. virginica* is said to have proved fertile under a net.

IRIS VERSICOLOR L. Larger blue flag.—This flower is described by Professor Goodale in "Wild Flowers of America," 32-35, and is there illustrated by a drawing by Isaac Sprague.

Newly opened flowers show the anthers dehiscent, but the stigmatic lobe is so closely appressed to the summit of the style that the true stigma is not touched by a bee entering the flower. Then in the early stages the tip of the anther lies against the stigma lobe and prevents its being reflexed. Later the style lengthens and the lobe loosens so that the true stigma may be touched. From the above it will be seen that the flower shows a tendency to proterandry.

The flower is adapted to long-tongued bees. I have seen it visited by *Bombus americanorum* F. ♀, *B. pennsylvanicus* DeG. ♀, and *Synhalonia frater* Cr. ♂♀, ab. I have also seen a beetle, *Trichius piger* F., enter the flower so as to effect pollination, but this insect cannot reach the nectar. Sometimes butterflies obtain the nectar in an illegitimate way by backing down to the base of the flower and inserting their proboscides between the bases of the "falls" and the style divisions. *Chrysophanus thoe* B.-L. and *Pamphila peckius* Kby. were observed stealing the nectar in this way.

The flowers bloom from May 20th to June 14th.

In New Hampshire, Weed (31) saw the flowers visited by bumble-bees, of which the most abundant species was *Bombus terricola*, and occasionally by some smaller bees. A more frequent visitor was "a good-sized syrphid fly—apparently a species of *Rhingia*." Several species of skippers (*Hesperidæ*) and *Sphingidæ* stole the nectar from the outside, as described above, *Hemaris thysbe* sometimes sucking in the legitimate way.

On the pollination of *Iris* see:

(1) Sprengel, Das entdeckte Geheimniss. 20, 43-4, 69-79. 1793. *I. pseudacorus*, *xiphium*, *germanica*, *sibirica*.—(2) Hildebrand, Geschlechtervertheilung bei den Pflanzen 59. 1867.—(3) Axell, On anordningarna för de fanerogama växternas befruktning 114. 1869. *I. pseudacorus*.—(4) Müller, Befruchtung der Blumen 67-70. 1873. Fertilization of Flowers 543-7. 1883. *I. pseudacorus*.—(5) Kerner, Schutzmittel des Pollens 12. 1873.—(6) Delpino, Ulteriori osservazioni Pt. II. fasc. 2. Atti d. Soc. Ital. d. Sci. Nat. in Milano. 16: 196, 201, 217, 220, 235, 263, 282, 340. (48, 53, 69, 72, 87, 115, 134, 192) 1873. 17:—(203-4, 247) 1874. *I. aphylla*, *viscaria*, *germanica*, *xiphium*, *halofila*, *graminea*, *florentina*, *pseudacorus*.—(7) Gray, Botany for young people. II. How plants behave 21, 25. 1875.—(8) Lubbock, British wild flowers in relation to insects 176. 1875. *I. pseudacorus*.—(9) Meehan, On self-fertilization and

cross-fertilization of flowers. Penn Monthly, N 1876. Sep. pamphlet (4). 1877.—(10) Delpino, Dicogamia ed omogamia nelle piante. Nuovo Giorn. Bot. Ital. 8: 143. 1876.—(11) Errera et Gevaert, Sur la structure et les modes de fecondation des fleurs. Bull. Soc. bot. de Belgique 17: 149. 1878. (Just Bot. Jahresbericht 6¹: 310)—(12) Hildebrand, Die Farben der Blüthen in ihre jetzigen Variation und früheren Entwicklung 36. 1879. (Just 7¹: 110)—(13) Dodel-Port, Die Liebe der Blumen. 4, 5: 185-240. 1880. (Just 8¹: 183)—(14) Gray, Structural Botany, 230. 1880. *I. pumila*.—(15) Focke, Nägeli's Einwände gegen die Blumen-theorie, erläutert an den Nachtfalterblumen. Kosmos 14: 295. 1884. Just 12¹: 668)—(16) Leow, Beobachtungen über den Blumenbesuch von Insekten an Freilandpflanzen. Jahrb. Bot. Gartens Berlin 3: 84, 96 (16, 28) 1884. *I. xiphioides, germanica, sibirica*.—(17) Licopoli, Sull polline dell' Iris tuberosa ed altre piante. Rendic. Accad. Sci. Fis. e Mat. Napoli 24:—1885. [No. 8.]—(18) Licopoli, Le pollen de l' Iris tuberosa. Journ. de micrographie 1886: No. 2.—(19) Ludwig, Ein neuer Fall verschiedener Blütenformen bei Pflanzen der nämlichen Art, und ein neues Kriterium der Schmetterlings- und Hummelblumen. Biol. Centralblatt 6: 24. 1887. (Just 15¹: 426)—(20) Licopoli, Sull polline dell' Iris tuberosa. Atti d. r. Acad. d. Sci. Fis. e Mat. II. 2:—1888—(21) Pax, Iridaceæ, Engler und Prantl, Die nat. Pflanzenfamilien 10 u. 17: 140-1. 1888. (Just 16¹: 554)—(22) Loew, Beiträge zur blütenbiologischen Statistik. Verh. Bot. Ver. Prov. Brandenburg 31: 43. 1890. *I. sibirica*.—(23) Kerner, Pflanzenleben 2: 93, 111, 173, 197, 247. 1891. *I. germanica, odoratissima* etc. (Just 17¹: 528)—(24) Dodel-Port, Zur Kenntniss der Befruchtungserscheinungen bei *Iris sibirica*. Testsch. z. Feier d. 50 Jahr. Doctorjubiläums der Herren Nägeli u. Kölliker. 1891.—(25) Ludwig, Zur Biologie der phanerogamischen Süßwasserflora (64) Zacharias, Das Thier- und Pflanzenleben des Süßwassers. 1891.—(26) Mac Leod, De Pyreneeënbloemen en hare bevruchting door insecten 306. 1891. *I. pyrenaica*.—(27) Mac Leod, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Bot. Jaarboek 5: 168, 315. 1893. *I. pseudacorus*.—(28) Gibson, The welcomes of the flowers. Harper's Monthly 88: 560. Mr 1894.—(29) Dodel-Port, Biologischer Atlas der Botanik. Serie "Iris." 1894. *I. sibirica*, plates and text. (Knuth Bot. Centralblatt 58: 95)—(30) Loew, Blütenbiologische Floristik 64-5, 346 391. *I. xiphioides, pseudacorus, sibirica*. 1894.—(31) Weed, Ten New England blossoms and their insect visitors 98-104. 1895.

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